Roadway Departure Warning System Independent Evaluation

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Independent Evaluation Topics

- Overview
  - Purpose of Independent Evaluation
  - Roles and Responsibilities
- Independent Evaluation
  - Goals
  - Milestones
- Data Needs

Purpose of Independent Evaluation

- Evaluate Roadway Departure Warning System (RDWS), objectively and independently
- Achieve four IVI evaluation goals, assess:
  - safety benefits
  - driver acceptance
  - system performance
  - long-term deployment and cost forecast

Roles / Responsibilities

Proposer

- Develops system
- Integrates in vehicles
- Installs DAS
- Recruits subjects
- Performs FOT
- Collects test data
- Collects survey data
- Copies/transfers data

Evaluator

- Identifies data needs
- Develops evaluation plan
- Helps design FOT to satisfy evaluation needs
- Performs characterization testing
- Coordinates FOT data transfer
- Analyzes test and survey data
- Assesses safety, acceptance, etc.

Evaluation Goals

- Understand Safety Benefits of RDWS
- Determine Driver Acceptance of RDWS
- Characterize RDWS Performance and Capability
- Assess RDWS Deployment Rates and Prices

Goal: RDWS Safety Benefits

How many crashes will be avoided?

- *Do drivers drive more safely with RDWS?*
- *Do RDWS-equipped vehicles have fewer or less-severe near collisions?*
- *How does overall traffic safety change as RDWS deployment varies?*

⇒ Addressed using FOT sensor data and crash statistics

Safety Benefits Estimation Measures of Performance

- *Do drivers drive more safely with RDWS?*
  - *speed deviation, lane deviation, acceleration levels*
- *Do RDWS-equipped vehicles have fewer or less-severe near collisions?*
  - *near-departures, actual departures (frequency, severity)*
- *How does overall traffic safety change as RDWS deployment varies?*
  - *combine deviation and departure measures with crash statistics, using simulation and analysis*

Goal: Driver Acceptance

Ease of Use	Ease of Learning	Adaptation	Perception	Endorsement
•Variation in information processing •Awareness of RDWS state •Channel capacity •Interface use •Use patterns •Reaction to nuisance/false alerts •Controls use •Alert discrimination	•Time to learn •Utility of instructions •Ability to retain	•Allocation of activities •Trip patterns •Vigilance •Behavior adaptation •Visual accommodation	•Safety •Skill enhancement •System integration •Driver workload	•Interest in purchasing •Accept in rental vehicle •Willing to endorse •Amount willing to pay

⇒ Addressed primarily using survey data

Goal: Performance and Capability

Sensors

- Types
  - edge
  - forward
  - map based
- Locations
- Curvature estimates
- Profiles and ranges

Alert Algorithm

- Response envelope (reaction time and severity of evasive maneuver)

Driver-Vehicle Interface

- Display type
- Readability
- Audible level and discrimination

Measured Performance

Objective Tests

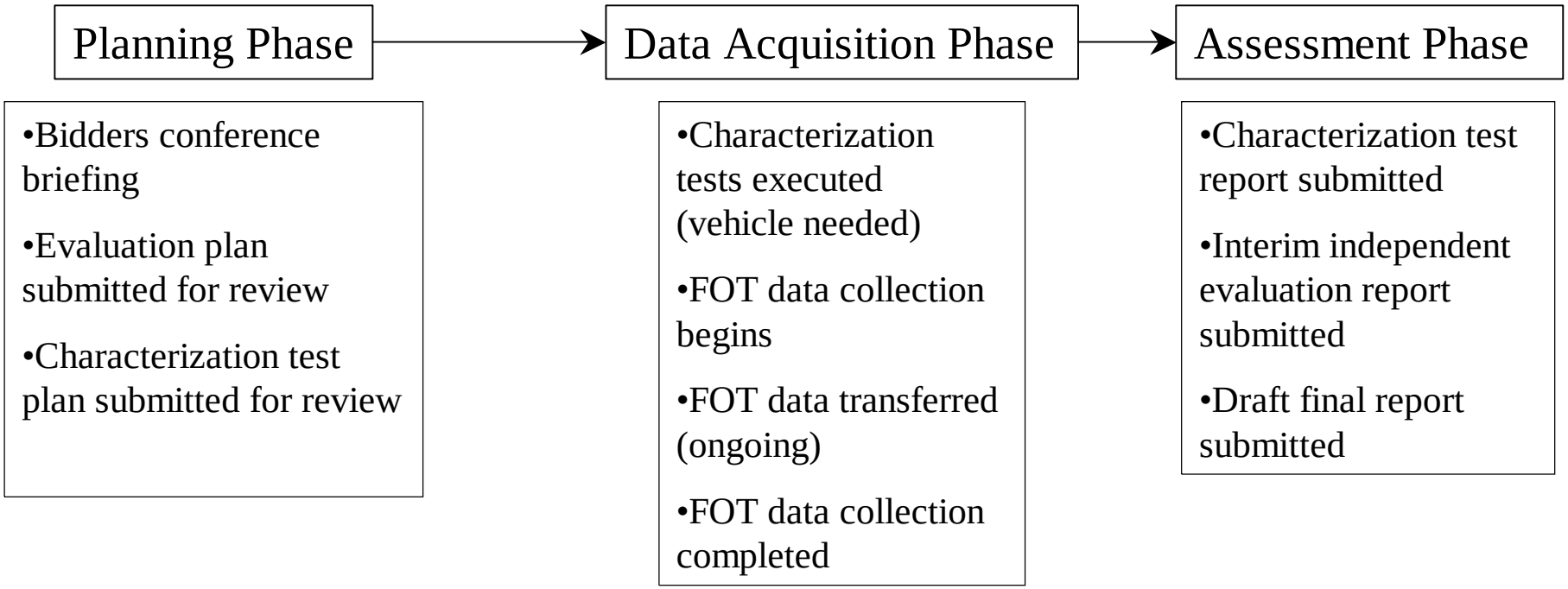
- Alert scenarios
- False alert scenarios

⇒ Addressed using measured data during characterization tests with vehicle

Goal: Deployment Rates and Prices

- Availability and price over 15 years
- Activities needed to expedite deployment

Evaluation Milestones



Straight Road Departure Analysis

- Crash prevention boundary (CPB)

$$t_s = \frac{1}{\sin q}\left[\frac{W}{V} - \frac{V}{a_l}(1-\cos q)\right]$$

t_s = time when steering initiated, after crossing boundary

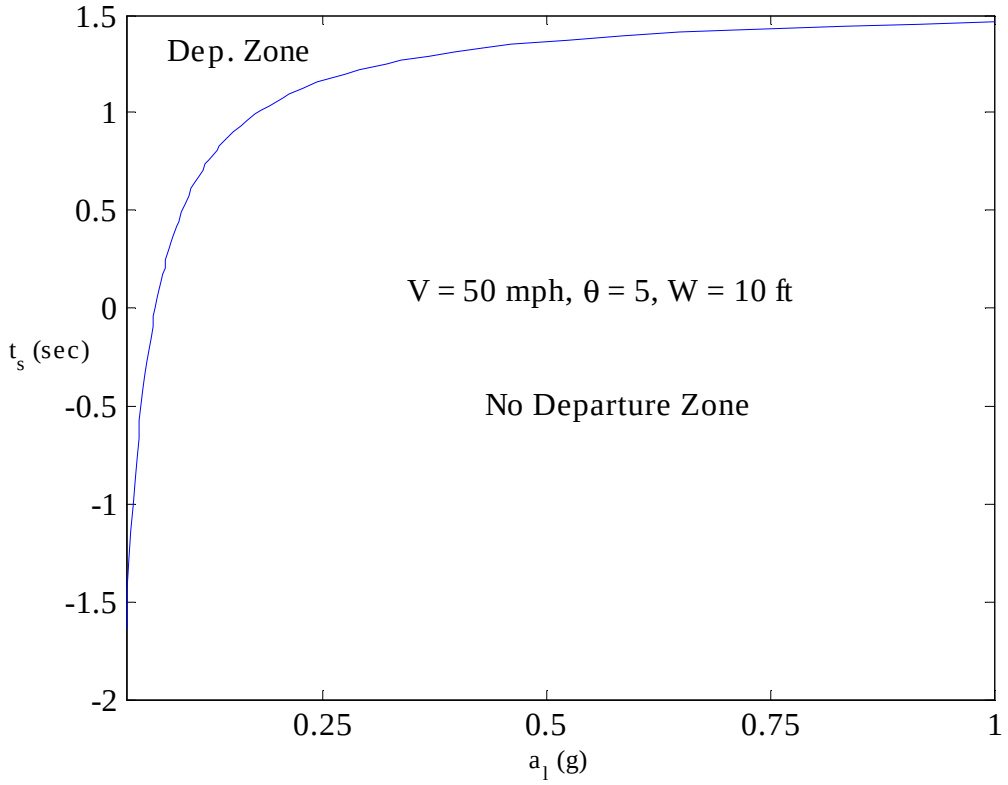
q = relative heading angle

W = shoulder width

a_l = lateral acceleration

V = speed

Straight Road Departure CPB Plot



Curved Road Departure Analysis

- Kinematics more complicated: need to consider vehicle's and road's radii of curvature, in addition to speed, shoulder width, etc.
- CPB plot has similar shape to straight road CPB plot
- as t_s increases, required a_l increases

FOT Data Needs - Overview

Need data to form objective conclusions regarding safety benefits, acceptance, and performance

- DOT, Evaluator, Proposer coordinate data needs
- Proposer installs sensors and DAS
- Proposer collects sensor data
- Data stored on vehicle, uploaded periodically
- Proposer collects survey data (from subjects)
- Data shared with evaluator in timely manner
- Evaluator coordinates data transfer

Data Needs - Categories

- Kinematic (speed, accelerations)
- Location (absolute, relative to lane edge)
- Orientation (heading relative to lane)
- Video (forward, side, road, driver)
- Independent system (truth)
- 10 Hz sample rate

$\Rightarrow$ Data collection both continuous and triggered

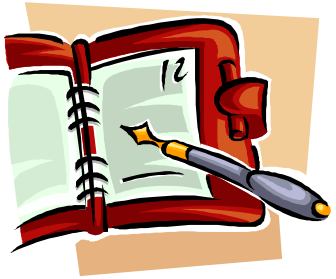
Sample Data Requirements

1. vehicle ID number
2. in lane lateral position
3. relative heading angle
4. velocity
5. longitudinal acceleration
6. lateral acceleration
7. yaw rate
8. steering wheel angle
9. manual braking flag
10. brake pressure
11. RDWS set positions
12. system status
13. displayed information
14. alert level and frequency
15. haptic enable
16. road condition
17. wiper stalk active
18. rain
19. ambient temperature
20. ambient light level
21. road curvature near/far and confidence levels
22. lane width / confidence
23. shoulder width / confidence
24. time
25. day
26. long / lat (DGPS/other)
27. compass heading
28. forward video
29. driver video
30. downward video
31. audio / concern data
32. distance / time in trip
33. driver distraction level
34. driver ID number
35. driver age
36. driver gender
37. driver exposure category
38. date
39. independent “truth” data
40. roadway type
41. road-edge incursions
42. throttle level
43. lane change status
44. lane position

Sample Scope of FOT to Meet Evaluation Data Needs

- ≥ 10 vehicles
- ≥ 100 participants, age and gender representative

- ≥ 1 year data collection duration
- Participant duration example
  - ≥ 1 week with and without RDWS
  - ˜ 4 – 6 weeks for some subjects



- ≥ 1000 miles / participant